

altitude 1,570 ft. It is allied to *I. apocyni* Felt and its related forms, from which it may be readily separated by the yellowish orange body and the structure of the genitalia.

Male.—Length 1 mm. Antennæ probably twice the length of the body, thickly haired, pale straw; fourteen segments, the fifth having the stems with a length three and one-half and four and one-half times their diameters, respectively; fourth palpal segment with a length one-half greater than the third. Body a somewhat variable yellowish or yellowish orange, the terminal clasp segment of the genitalia apparently tipped with fuscous. Wings yellowish. Halteres, coxæ and femora basally pale yellowish, the distal portion of femora, tibiæ and tarsi mostly yellowish straw, the latter possibly indistinctly banded; claws simple, the pulvilli rudimentary. Genitalia; basal clasp segment moderately stout; terminal clasp segment long; dorsal plate moderately long, broad, triangularly emarginate, the lobes roundly truncate, the lateral angles being slightly produced and sparsely setose; ventral plate long, broad, broadly and roundly emarginate, the lobes short, broad.

Female.—Length 2 mm. Antennæ as long as the body, sparsely haired, whitish basally, light brown apically; stems whitish transparent, the fifth with a stem three-fourths the length of the cylindric basal enlargement, which latter has a length two and one-half times its diameter. Palp; the first segment with a length four times its diameter, the second a little longer, stouter, the third one-fourth longer than the second, more slender, the fourth one-half longer than the third, more slender. Body a uniform yellowish or yellowish orange. Wings, coxæ, halteres and femora basally yellowish, the distal portion of femora, tibiæ and tarsi light brownish. Ovipositor short, the terminal lobes broadly oval and thickly setose. Both sexes were taken together and are probably conspecific. Type Cecid. 1486.

BIOLOGICAL NOTES CONCERNING DROSOPHILA AMPELOPHILA.

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This little fruit-fly has been of unusual importance in the recent study of evolution, especially of that phase of the study which deals with inheritance. Not only have cases of simple Mendelian characters been conveniently studied by its aid but more complex ones have been analyzed although some are not yet "explained." The work of Morgan and his pupils with it has demonstrated beyond a

doubt a relation between certain somatic characters and the sex chromosome. These "sex-linked" characters are not secondary sexual characters but it is probable that this fly may help us to an understanding of the latter since there seems to be a relation, possibly indirect, between the two.¹

The species also offers an excellent opportunity to study those problems which we, curiously enough, term "biological." In nature it feeds on all sorts of fermenting material and has been reared even from human excrement. In the laboratory the most convenient and satisfactory food is over-ripe banana. It is difficult to say just how many eggs are laid by each female but the average is probably two or three hundred. Fig. 491 in Packard's (1898) Text Book of Entomology shows the pair of filaments with which the eggs are provided. In oviposition the end of the egg bearing these is the last to leave the oviduct and they protrude from the fermenting mass in which the egg is usually laid, probably serving a respiratory function.

It sometimes happens that the egg hatches before it leaves the female. As this does not usually occur unless no suitable material in which to oviposit has been found it is improbable that any of the oviviparous offspring ever reach maturity. The longest period at normal temperatures required for hatching that I have observed is about fifty hours. The average is probably less than thirty. Such observations are difficult to make with large numbers and I have combined the egg and the larval stages in most of my work.

The larvæ usually feed near the surface of the fermenting mass. I have reared the fly for several generations in a glass of stale beer. In this case the larvæ were able to keep a position just under the surface film where it met the glass. The length of the larval period varies greatly according to temperature, food supply and other conditions. The accompanying table gives the result of an experiment involving about 4,000 flies fed on banana at a fairly constant temperature approximating 25° C. Pupation began four days after egg-laying and came on with a rush during the fifth and sixth days; then the number gradually dropped off until the four individuals which required eleven days. There is little or no sexual difference,

¹ Lutz, F. E., 1913, "Experiments Concerning the Sexual Difference in the Wing Length of *Drosophila ampelophila*," Journal of Experimental Zoölogy, XIV, pp. 267-273.

that which was found being in favor of the males having a shorter egg-larval life than the females but the difference was well within the probable error.

TABLE SHOWING THE NUMBER OF INDIVIDUALS COMPLETING THEIR EMBRYONIC PERIODS IN A GIVEN NUMBER OF DAYS.

Days.	Egg-Larval.	Pupal.
2		1
3		3
4	92	1,087
5	1,258	2,398
6	1,435	438
7	744	33
8	405	9
9	91	6
10	14	0
11	4	2
12		1

In order to pupate the larvæ crawl to the dryer portions of the food or even entirely out of it. If pupation occurs in the food the horns of the pupal case nevertheless protrude into the air. The table shows that at first the flies emerge in large numbers but that a few lag along taking more than twice the average time. A sexual difference is more pronounced in the pupal period than in the egg-larval. Among 262 offspring of a single pair the average pupal period of the sisters at 25° C. was 5.0 days and that of the brothers 5.3 days.

The sex ratio varies greatly in different families. Moenkhaus¹ found that among 26,933 individuals there were 1,126 females to each male, but in certain families it is occasionally two to one or even more. It does not change with the age of the parents. The details of the work done upon the modification and inheritance of the sex ratio are too complicated to be taken up here.

The newly emerged adults expand their wings as they walk about. In a few minutes they are ready to fly. In this they are almost absolute slaves to light, going in the direction of its greatest intensity.

¹ Moenkhaus, W. J., 1911, "The Effects of Inbreeding and Selection on the Fertility, Vigor and Sex Ratio of *Drosophila ampelophila*," Journal of Morphology, XXII, pp. 123-154.

However, acetic acid or fruit odors will overcome this reaction and they will go into dark places to get at their food. Payne¹ has found that even after these flies had been reared in darkness for sixty-nine generations they still reacted to light with nearly normal vigor. The reaction is slow among newly emerged flies but soon becomes more rapid, reaching a maximum in about eighteen hours, and then very gradually sinks as the flies age. My experience also indicates that the females react about twice as quickly and definitely as the males. Moenkhaus, on the other hand, found the males to be slightly more responsive than the females. Possibly the fact that the tube in his apparatus was inclined at an angle of twenty-five degrees explains the difference since it introduces the reaction against gravity.

Both males and females become sexually active the second day after emerging. There is usually a sort of courtship dance before mating in which the male or males go from side to side and around the female, flitting their wings and attempting to crawl on her back. Unless the female be an old one which has not recently mated this courting is usually kept up for from several minutes to an hour or more, the female preventing mating by curling the tip of her abdomen downwards and keeping her wings together. The duration of actual copulation is also variable. It averages about half an hour but may continue for an hour and a half. A vigorous male will mate repeatedly during a single day and occasionally the same is true of the females. It seems to be necessary for the female to mate several times during a normal life or the late developed eggs will not be fertile.

Apparently inbreeding is not detrimental. Castle and his co-workers² have found that, if it does reduce productiveness, fertility may be maintained nevertheless by selection. Sterility is not rare in wild material. Thus among twenty-five random matings of wild flies I found two to be sterile. Neither does inbreeding seem to be

¹ Payne, F., 1911, "*Drosophila ampelophila* Loew Bred in the Dark for Sixty-nine Generations," Biological Bulletin, XXI, pp. 297-301.

² Castle, W. E., Carpenter, F. W., Clark, A. H., Mast, S. O., and Barrows, W. M., 1906, "The Effects of Inbreeding, Cross-breeding and Selection upon the fertility and variability of *Drosophila*," Proc. Amer. Acad. of Arts and Sciences, XLI, pp. 731-786.

accompanied by degeneration of external parts even when accompanied by disuse.¹

The normal length of adult life, like all similar characters, is largely dependent upon environment. Moenkhaus states that they kept females alive for 153 days but does not say what the conditions were. Among 267 females which I kept well supplied with food at room temperatures but isolated from males, only one lived to be 80 days old. The average age at death was 26.4 days. The longest lived, unmated male under the same conditions died in 90 days, the average being 32.8 days.

Another series of unmated flies (116 males and 124 females) were kept at a relatively constant temperature of 20° C. and furnished water but no food. Three females and one male lived 96 hours. The average age at death was 68.6 hours for the females and 66.4 for the males. In another series in which the conditions were the same except that the temperature was five degrees higher, the females withstood starvation for only 60.7 hours, on the average, and the males 55.6 hours. In still another series the temperature was 20° C. but, in addition to withholding food, no water was supplied except that evaporating from their own bodies. The average females lived 56 hours and the average males 53.5 hours. It is difficult to say why the females can withstand starvation better than the males but have a shorter natural life, at least when unmated.

The materials which kept these starved individuals alive were all laid up by the feeding larvæ for no food was supplied after the fly emerged and, of course, the pupæ did not feed. I was surprised, therefore, to find that those which were better able to withstand starvation in the adult stage had had a shorter larval period, and fed for a shorter time, than the others. The data for this are still being worked up and will be published later but the explanation probably is that the physiologically strong larvæ were able to complete their larval history quickly and gave rise to physiologically strong adults.

¹ Lutz, F. E., 1911, "Experiments with *Drosophila ampelophila* Concerning Evolution," Carnegie Institution of Washington, Publication No. 143.